

A REVISION OF THE GENUS FRASERA¹

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INTRODUCTION

The present study was undertaken to determine the status of the genus *Frasera*. In recent years it has received various treatments in the numerous local manuals and floras; certain authors have considered it a portion of the more polymorphic and widespread genus *Swertia*, others have regarded it as a distinct generic unit, whereas still others have segregated it into several smaller genera.

Sincere appreciation is due the curators of the herbaria of the University of California, Field Museum of Natural History, Gray Herbarium of Harvard University, and the Los Angeles Museum, for the loan of material necessary in this study. For the use of the excellent library and herbarium of the Missouri Botanical Garden, especial thanks are due the Director, Dr. George T. Moore. The writer desires to express his appreciation to Dr. J. M. Greenman, Curator of the Herbarium of that institution, and to Dr. Mildred E. Mathias, Research Assistant, who have so generously given their advice from time to time.

HISTORY OF THE GENUS

Walter² described the genus *Frasera* in 1788, naming it in honor of John Fraser, a noted plant collector of the eighteenth century. A single species, *Frasera caroliniensis*, was assigned to the new genus. Fifteen years later Michaux³ recognized the genus, renaming the species *F. Walteri*. Pursh⁴ in 1814 recognized

¹ An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

² Walt. Fl. Carol. 87. 1788.

³ Michx. Fl. Bor. Am. 1: 96. 1803.

⁴ Pursh, Fl. Am. Sept. 1: 101. 1814.

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F. Walteri, indicating its occurrence "In swamps of Lower Carolina and on the borders of lakes in Pennsylvania and New York."

In 1828 Rafinesque⁵ included the genus in his 'Medical Flora,' listing but a single species, *F. verticillata*, which he admitted to be identical with *F. caroliniensis*. At the same time Rafinesque suggested the name *Mesadenia* as being more appropriate than *Frasera*. Four varieties of *F. verticillata* were also proposed in the 'Medical Flora.'

In 1839 two closely related species, *F. nitida* and *F. albicaulis*, were added to the genus. The one, *F. nitida*, was described by Bentham⁶ from material collected by Hartweg "in montibus Sacramento," California, and the other, *F. albicaulis*, by Grisebach,⁷ based on specimens collected by Douglas in the vicinity of Spokane, Washington, and Kettle Falls, British Columbia.

Grisebach⁸ revised the Gentianaceae for Hooker's 'Flora Boreali-Americana' in 1840, publishing another of Douglas's manuscript names as *F. speciosa*. In 1844, in de Candolle's 'Prodromus' Grisebach⁹ recognized the genus *Frasera* and included all the species previously known.

In 1851 Hooker¹⁰ published *F. thyrsiflora*. During the later years of the same decade Dr. John Torrey added two species to the genus, namely, *F. paniculata*¹¹ and *F. Parryi*.¹² Kellogg¹³ in 1862 proposed the new genus *Tesseranthium*, designating the type species as *T. radiatum*. It has since been shown that *T. radiatum* Kellogg is conspecific with *Frasera speciosa* Douglas.

Since 1871 approximately fifteen new species and varieties have been described in the genus but no recent comprehensive survey of the group has been made. Treatments of the genus have appeared in the various local manuals and floras; certain workers¹⁴ have segregated the genus into several closely allied genera,

⁵ Raf. Med. Fl. 1: 196. 1828.

⁶ Benth. Pl. Hartw. 322. 1839.

⁷ Griseb. Gen. et Sp. Gent. 330. 1839.

⁸ Griseb. in Hook. Fl. Bor.-Am. 2: 65-67. 1840.

⁹ Griseb. in DC. Prodr. 9: 131. 1844.

¹⁰ Hook. Kew. Jour. 3: 288. 1851.

¹¹ Torr. in Pacif. R. R. Rept. 4: 126. 1856.

¹² Torr. Bot. Mex. Bound. Surv. 156. 1859.

¹³ Kell. in Proc. Calif. Acad. Sci. 2: 142. 1862.

¹⁴ Rydb. Fl. Rocky Mts. 664-666. 1917, and ed. 2, 664-666. 1922.

namely, *Frasera*, *Tessaranthium* and *Leucocraspedum*; on the other hand, Gilg,¹⁵ in Engler and Prantl, 'Die Natürlichen Pflanzenfamilien,' and Jepson¹⁶ in his recent 'Manual' have merged the genus *Frasera* and its segregates with *Swertia*.

GENERAL MORPHOLOGY

Roots.—The prevailing root type in the genus *Frasera* is the tap-root. In the majority of species this tap-root grades directly into the stem, but in some of the western species, particularly *F. nitida*, *F. montana*, and *F. neglecta*, the root grades into a branching underground rhizome before being transformed into the aërial stem. The former group is therefore composed of biennial or short-lived species, whereas the latter is composed of perennials. Occasionally the biennial species may persist for more than two years, but that phenomenon is evidently never accompanied by the formation of a true rhizome as in the strictly perennial species.

The tap-root may be greatly thickened and fleshy, as in the species *F. caroliniensis*, *F. fastigiata*, and *F. speciosa*, or relatively slender and fibrous, as in *F. paniculata*.

Stems.—An herbaceous aërial stem terminates the unbranched crown of the root in the biennial or short-lived species. In the perennial species, however, the existence of the underground branching rhizome is a striking feature. The aërial stems show but slight variation, all being uniformly simple, erect, terete, and frequently strongly fistulose. The surface may be glabrous, glaucous, or variously pubescent. The height of the stem varies with the species. *Frasera caroliniensis* and *F. speciosa* have the highest stems, frequently reaching two or three meters. The far-western species are less conspicuous and rarely exceed one-half meter in height.

The stems of *F. caroliniensis*, *F. fastigiata*, and *F. speciosa* are truly foliose, the leaves ascending the stem at regular nodes, and grading into the foliaceous bracts of the inflorescence. In the remaining species, however, the stem may be described as scapose or subscapose, for the foliage is almost entirely limited to a basal

¹⁵ Gilg. in Engl. & Prantl, Nat. Pflanzenfam. 4²: 87. 1895.

¹⁶ Jepson, Man. Fl. Pl. Calif. 766. 1925.

rosette, the stem proper being naked or only bearing isolated and conspicuously reduced leaves at irregular intervals.

Leaves.—The simple, entire leaves are opposite or in whorls of three to six, disposed on an upright stem or forming a basal rosette, and are either sessile or petiolate. They vary in outline from ovate to almost linear. The margins of the leaves in certain species, such as *F. albomarginata*, often become conspicuously whitened and minutely tuberculate or papillate. While some of the plants of this group are glabrous throughout, certain species have a scaberulent tomentum. The texture of the leaves in the fresh state is with few exceptions somewhat fleshy; the leaves of dried pressed specimens, however, are more or less membranous. The venation of the leaves of the various species is characteristic; in *F. caroliniensis* and *F. fastigiata* a conspicuous midrib is developed, presenting a penninerved appearance, whereas in certain other species the veins are more or less parallel.

Inflorescence.—The mode of inflorescence is cymose and among the different species assumes characteristic modifications which have been found to be of taxonomic value. Text-figure 1 shows a diagram of the various types of inflorescence occurring in the genus. Each diagram represents a single axillary unit of inflorescence, b-b' representing the subtending leaves. In fig. 5 the condition of the leaf, b-b', subtending a single, much-branched peduncle, is here interpreted as a primitive inflorescence. Figures 4, 3, 2, and 1 show a progressive sequence in inflorescence specialization which culminates in the advanced type¹⁷ illustrated in fig. 1, in which several relatively disorganized peduncles and solitary flowers are borne in the axil of the subtending leaf (b-b'). The development of the advanced types is probably due to a successive shortening or a submergence of the primary axes of the simple axillary inflorescences until finally only the tips, or pedicels, remain distinct, giving the inflorescence a fasciculate appearance. The single axillary inflorescence type is exemplified by *F. paniculata* although the main axis is cymose. In *F. Parryi*, however, the main axis is unbranched, and the flowers are borne in a raceme.

¹⁷ Parkin, J. The evolution of the inflorescence. Jour. Linn. Soc. Bot. 42: 511-563. 1914.

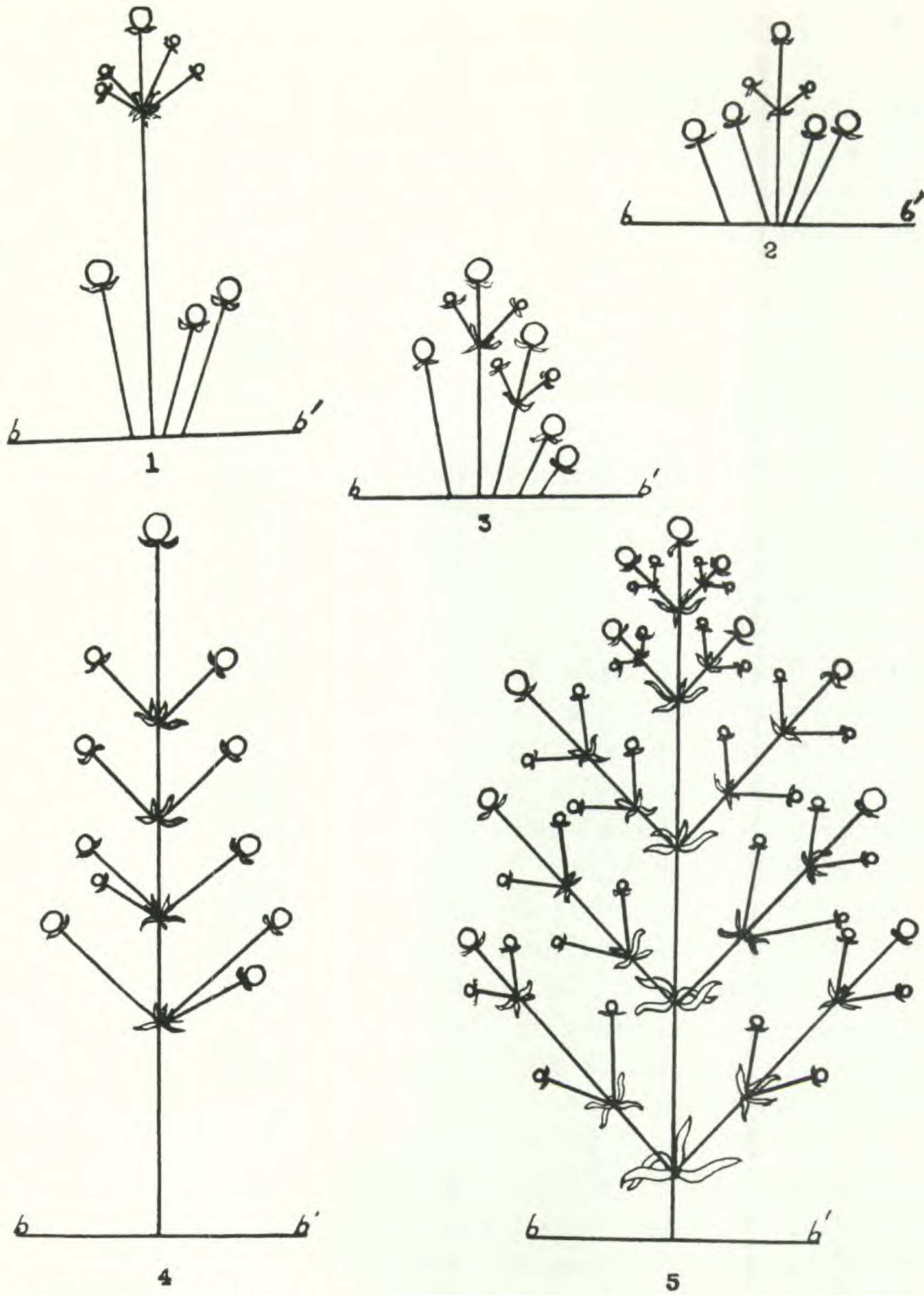


Fig. 1. Diagrams showing the various types of inflorescence within the genus *Frasera*:

1. *F. nitida*.
2. *F. speciosa*.
3. *F. caroliniensis*.

4. *F. Parryi*.
5. *F. albomarginata*.

The condition of the inflorescence of *F. caroliniensis*, *F. fastigiata*, and *F. speciosa* is more advanced than that of the foregoing species. In each, many pedicels, reduced peduncles, and numerous bracts are found in the axil of each leaf. This condition, as has been said before, is believed to be the result of the submergence of a single cyme.

The most specialized type of inflorescence occurs in *F. nitida* and related species. In these species the peduncle is usually obsolete and the leaf subtends several distinct pedicels. The presence of numerous bracts mingled with the pedicels, however, cannot be ignored.

Calyx.—The calyx is gamosepalous and deeply 4-parted, and at the base of the short tube there frequently occur minute filamentous processes known as squamellae. The lobes are usually subulate, but vary from linear to obovate.

Corolla.—The corolla is gamopetalous, deeply 4-parted, and rotate. There is considerable variation in size and shape of the lobes, some being oblong and mucronate, others obovate and acute, and still others oval or broadly oblong. The corolla, moreover, is rather firm in texture, and is usually greenish-white in color with the lobes often profusely blotched with blackish or dark-greenish maculations.

One or two glandular pits are borne on the ventral surface of each lobe. These structures (pl. 14), called foveae, assume bizarre and characteristic shapes, being usually circular, sagittate, oblong, or quadrate, at other times linear with an obcordate apex. The margins of the foveae are usually bordered by a conspicuous ciliation.

In several species, in addition to the foveae and generally contiguous with them, occurs a conspicuous *corona* or crown, which may be either fringed, petaloid, or a combination of both. In other species the crown is lacking, or almost obsolete.

Stamens.—There are four stamens, alternate with the lobes of the corolla. The filaments are inserted at the very base of the obscure tube, are about as long as the corolla, and linear or somewhat dilated at the base. The anthers are two-celled, oblong, versatile, extrorse, and longitudinally dehiscent. The pollen is granular.

Ovary.—The ovary is bicarpellary, unilocular, usually ovate-fusiform, and sessile; the terminal portion is gradually attenuated into a filiform style. The stigma is two-cleft, the plane of either lobe coinciding with the plane of placentation. The placentae are parietal and binate, and upon each placenta are arranged two to four rows of anatropous ovules.

Fruit.—The fruit is a capsule, enclosed by the persistent perianth. The capsule is usually flattened parallel to the valves, but in some species it is flattened contrary to the valves. The seeds are numerous, ovate or triangular, flat, and in some species variously winged about the margin.

GEOGRAPHICAL DISTRIBUTION

The distribution of the genus *Frasera* is limited to the region of North America lying between 25° and 50° North latitude, which is approximately coincident with the northern and southern boundaries of the United States. The genus occurs in two distinct areas, one in the eastern and southeastern United States, extending as far north as southern Michigan and west to the eastern limit of the great plains region, the other extending from the one hundredth meridian west to the Pacific coast. The former area is occupied by the single species, *F. caroliniensis*, while the remaining species are confined to the latter area, as the accompanying map indicates.

The genus at one time probably had a continuous transcontinental distribution and its present occurrence in two such widely separated areas is presumably the result of isolation following the invasion of the Upper Cretaceous sea which separated the continent into an eastern and western portion.

Although the western species seem to be more abundant at the higher altitudes, yet they are able to maintain themselves in a variety of habitats. The changes in the character of the plants are the results of the various environmental factors, soil, moisture, altitude, etc. *Frasera fastigiata*, for instance, grows in rich, moist valleys, developing thin membranous leaves, whereas the species of the mountainous and desert regions have a decidedly fleshy or coriaceous texture.

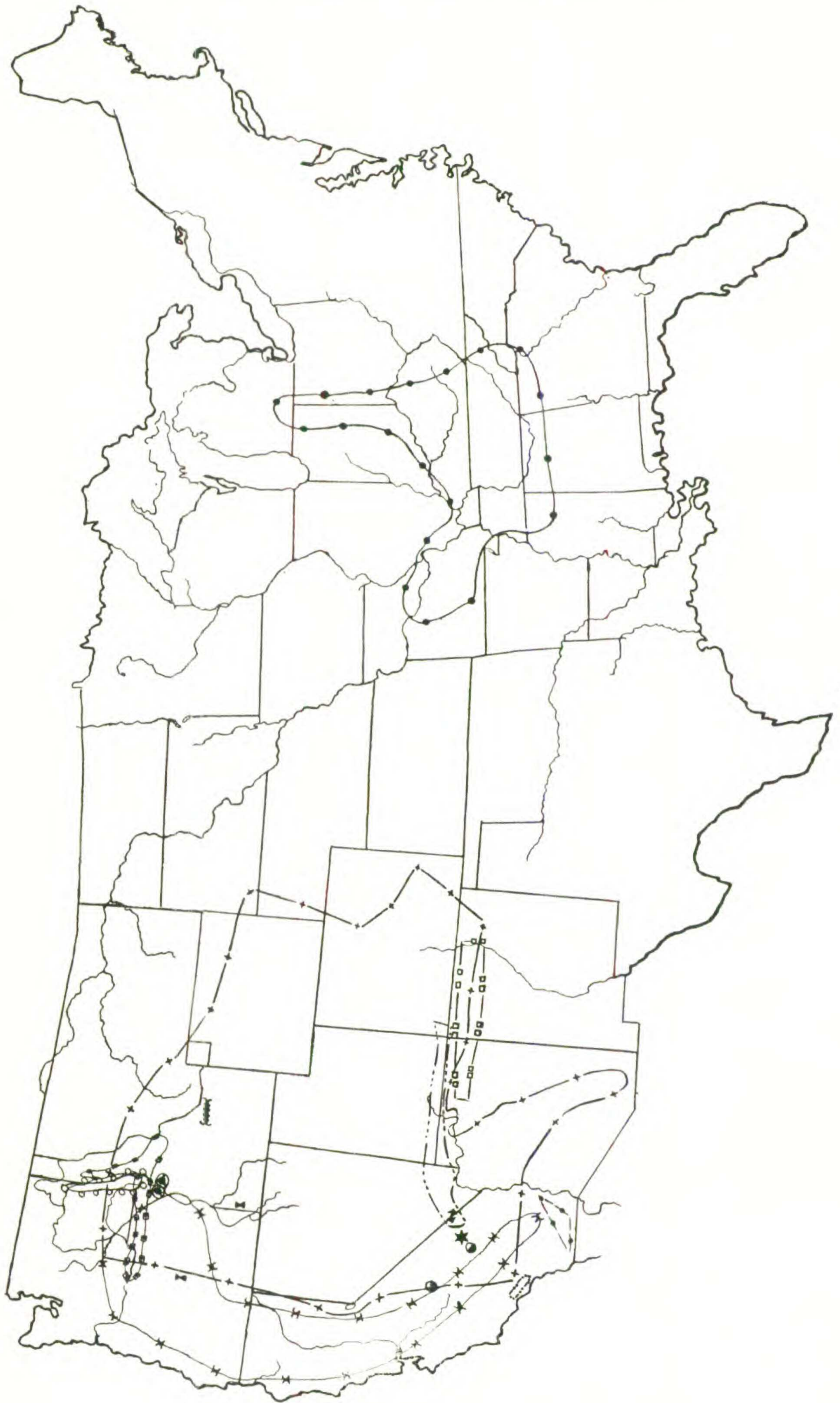


Fig. 2.

Fig. 2. Map showing the distribution of the genus *Frasera* in North America.

PHYLOGENY

The interrelationship among the various species of *Frasera* is so evident that any discussion concerning their phylogeny is problematical.

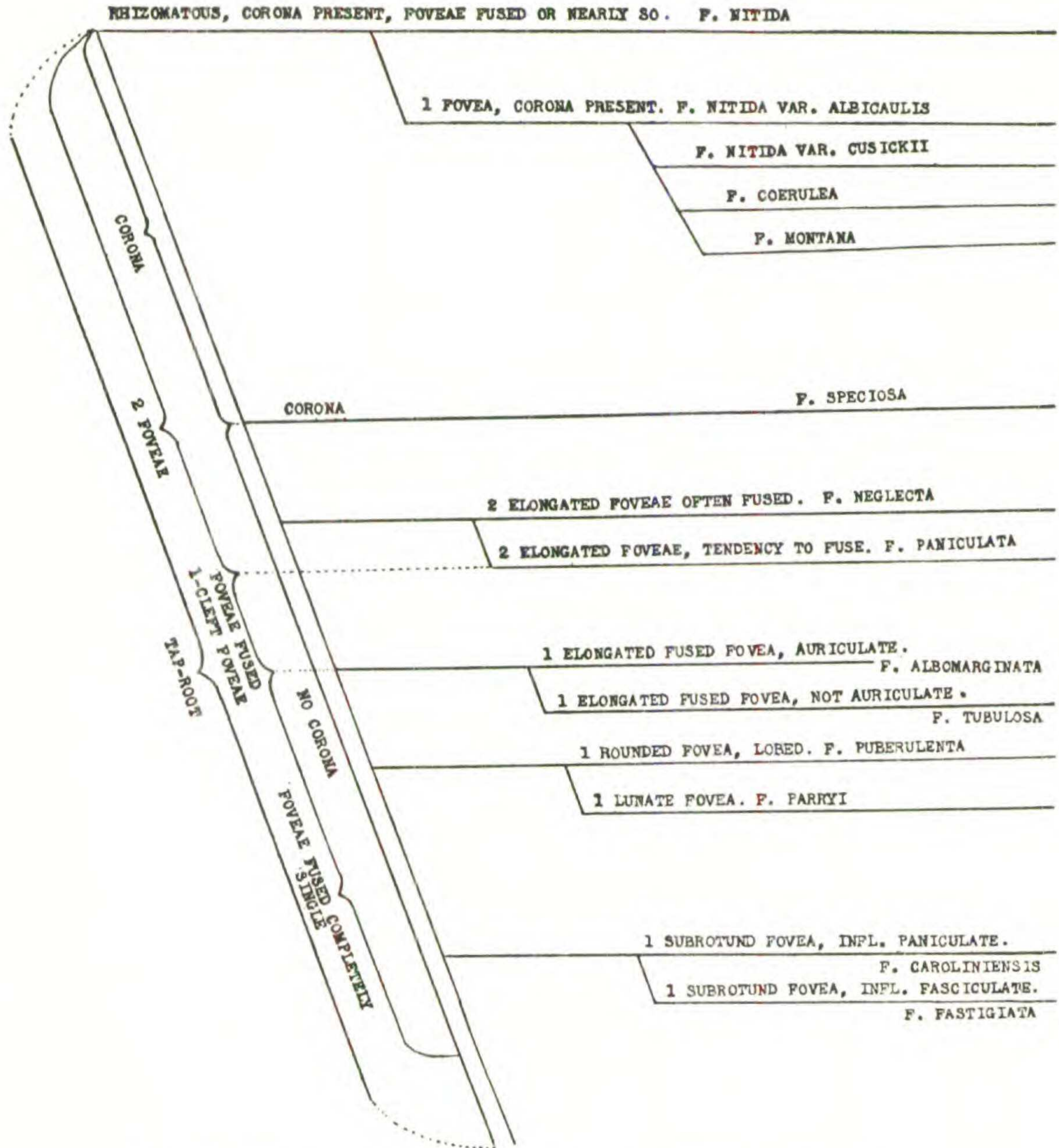


Fig. 3. Diagram showing tendencies toward fusion of the foveae.

The primitive floral condition in the genus may be considered as that represented by such species as *F. speciosa* and *F. nitida*, in which a corona and two foveae are present. The absence of corona and the occurrence of only a single fovea, as in *F. fastigiata*, represent the more advanced type of development.

Among the western species there are two lines of descent, one represented by the coastal species and the other by the more inland forms. The most primitive of the more coastal species is considered to be *F. nitida*, with a corona and two variously fused foveae. *Frasera neglecta*, with two more or less fused foveae, is probably a lateral offshoot from *F. nitida*. The second line of development begins with *F. speciosa*, the most primitive of the species in the genus because of its corona and two distinct



Fig. 4. Diagram showing probable lines of development within the genus *Frasera*.

foveae, as well as the somewhat primitive type of inflorescence in which only partial submergence of the peduncles occurs. *Frasera paniculata* and *F. albomarginata* are the least removed from *F. speciosa*. In the two former species the foveae have become variously fused. A more advanced condition is that represented by *F. Parryi* and *F. puberulenta*, with only a single variously cleft or lobed fovea. *Frasera fastigiata* and *F. caroliniensis* with a single fovea and a more advanced type of inflorescence culminate this line of descent.

These two lines of development within the genus, as illustrated in the accompanying charts (figs. 3 and 4) and distribution map

(fig. 2), are more or less paralleled by the geographical range of the various species.

MEDICINAL USAGE

In the early part of the nineteenth century *Frasera* was variously known as "American Colombo," "Colombo-root," "Columbia," "Indian Lettuce," "Yellow Gentian," "Golden Seal," "Curcuma," "Meadow Pride," "Pyramid," etc.

It is not now recognized in the 'United States Pharmacopoeia,' but one hundred years ago its medicinal properties were considered very great. Relative to its therapeutical effect, Dr. Daniel Drake¹⁸ writes as follows: "The root of *Frasera* is a pure, powerful, and excellent bitter, destitute of aroma. It may be used in powder, decoction, infusion, and tincture." Further, Rafinesque attributes to it an almost miraculous power: "Emetic and cathartic when fresh, tonic, antiseptic and febrifuge when dry. It has cured a wide spread gangrene of the lower limbs by internal use and external application when bark had failed."¹⁹ Others say that "it is employed in jaundice, scurvy, gout, and is a specific in hydrophobia!"

ABBREVIATIONS

The list of abbreviations of herbaria used in the citation of specimens is as follows:

- G = Gray Herbarium of Harvard University.
- F = Field Museum of Natural History.
- C = University of California.
- M = Missouri Botanical Garden.
- LA = Los Angeles Museum.

TAXONOMY

Frasera Walt. Fl. Carol. 87. 1788; Michx. Fl. Bor.-Am. 1: 96. 1803; Pursh, Fl. Am. Sept. 1: 101. 1814; Raf. Med. Fl. 1: 196. 1828; Benth. Pl. Hartw. 322. 1839; Griseb. Gen. et Sp. Gent. 330. 1839; in Hook. Fl. Bor.-Am. 2: 66. 1840; in DC. Prodr. 9: 131. 1845; Benth. & Hook. Gen. Pl. 2: 817. 1876;

¹⁸ Drake in Barton, Veg. Mat. Med. U. S. 2: 109. 1818.

¹⁹ Raf. Med. Fl. 1: 199-200. 1828.

Gray, Syn. Fl. N. Am. 2¹: 111, 125. 1878, and ed. 2, 2¹: 111, 125. 1886; Chapman, Fl. S. U. S., ed. 3. 340. 1897; Howell, Fl. N. W. Am. 447. 1897; Piper in Contr. U. S. Nat. Herb. 11: 451. 1906; Gray, Man. Bot., ed. 7, 659. 1908; Britt. & Brown, Ill. Fl. 3: 14. 1913; Small, Fl. S. E. U. S. 931. 1913; Wootton & Standl. in Contr. U. S. Nat. Herb. 19: 499. 1915; Rydb. Fl. Rocky Mts. 664. 1917, and ed. 2, 664. 1922; Tidestrom in Contr. U. S. Nat. Herb. 25: 417. 1925; Jepson, Man. Fl. Pl. Calif. 765. 1925.

Mesadenia Raf. Med. Fl. 1: 198. 1828.

Tesseranthium Kellogg in Proc. Calif. Acad. Sci. 2: 142. 1862.

Tessaranthium Rydb. Fl. Rocky Mts. 666. 1917, and ed. 2, 666. 1922.

Sweetia L. acc. to O. Ktze. Rev. Gen. 2: 430. 1891, in part; Gilg in Engl. & Prantl, Nat. Pflanzenfam 4²: 87. 1895, in part.

Leucocraspedum Rydb. Fl. Rocky Mts. 665. 1917, and ed. 2, 665. 1922.

Swertia L. acc. to Jepson, Man. Fl. Pl. Calif. 766. 1925, in part.

Herbaceous caulescent biennials or perennials from a tap-root, sometimes forming rhizomes. Stems erect, simple, terete, fistulose, leafy, scapose to subscapose. Leaves opposite or whorled, lanceolate to spatulate, sessile or narrowed at the base into a petiole, membranous or coriaceous, sometimes white-margined, penninerved to subparallel-veined. Inflorescence terminal, flowers disposed in a subcorymbose, thyrsoidal or loosely paniculate cyme. Calyx 4-parted, the lobes deeply cleft, subulate, acute. Corolla rotate, 4-parted nearly to the base; the tube shallow, flat, with or without a conspicuous crown; the lobes convolute in the bud and bearing on the ventral surface one or two more or less fringed glandular foveae. Stamens four, inserted on the corolla tube and alternate with the lobes; filaments linear or somewhat dilated at the base; anthers 2-celled, oblong, versatile, extrorse, longitudinally dehiscent. Ovary bicarpellary, unilocular, the terminal portion gradually attenuate into a filiform style; stigma 2-cleft; placentae parietal, binate, bearing numerous anatropous ovules. Capsule ovate, bivalvate, compressed either parallel or contrary to the valves, 4–20-seeded. Seeds ovate, triangular, flat, pitted, variously winged or rugose. Embryo erect.

Type species: *Frasera caroliniensis* Walt. Fl. Carol. 87. 1788.

KEY TO THE SPECIES

- A. Plant not scapose; inflorescence foliaceous-bracteate throughout; leaves not white-margined.
- B. Corolla-lobe bearing a pair of foveae upon its ventral surface; crown conspicuous; capsule flattened contrary to the valves....1. *F. speciosa*
- BB. Corolla-lobe bearing a single fovea upon its ventral surface; crown inconspicuous or lacking; capsule flattened parallel to the valves.
- C. Inflorescence relatively loose, leafy; pedicels exceeding the flowers; corolla-lobes oblong-ovate, 1–2 cm. long; species mostly of the southeastern United States.....2. *F. caroliniensis*
- CC. Inflorescence relatively compact, bracteate; pedicels shorter than the flowers; corolla-lobes oblong-lanceolate, 0.8–1 cm. long; species of the northwestern United States.....3. *F. fastigiata*
- AA. Plants scapose to subscapose; inflorescence not foliaceous-bracteate throughout; leaves may or may not be conspicuously white-margined.
- B. Perennials from a branching somewhat woody rhizome; leaves opposite.
- C. Basal leaves lance-attenuate to oblanceolate, 5–20 cm. long.
- D. Plants 3 dm. or more high; flowers several in the axils.
- E. Lower branches of the inflorescence long-pedunculate, 5–10 cm. long; flowers relatively large.....4. *F. neglecta*
- EE. Lower branches of the inflorescence short-pedunculate, 1–1.5 cm. long; flowers relatively small.
- F. Inflorescence about 3 cm. in diameter.....5. *F. montana*
- FF. Inflorescence about 2 cm. in diameter.
- G. Plants glabrous.....6. *F. nitida*
- GG. Plants more or less pubescent.....6a. *F. nitida* var. *albicaulis*
- DD. Plants from 1.5–2.5 dm. high; flowers one or two in the axils.
- E. Inflorescence dense.....6b. *F. nitida* var. *Cusickii*
- EE. Inflorescence open.....7. *F. coerulea*
- CC. Basal leaves spatulate, 4–9 cm. long.....8. *F. tubulosa*
- BB. Perennials from a somewhat woody tap-root; leaves opposite.
- C. Inflorescence a paniculate cyme; crown absent; fovea oblong.....
-9. *F. puberulenta*
- CC. Inflorescence a corymbose cyme; crown present; fovea lunate.....
-10. *F. Parryi*
- BBB. Perennials from a somewhat woody tap-root; leaves whorled.
- C. Pedicels 0.5–0.6 cm. long; fovea not two-parted, apical tooth lacking.
- D. Plants glabrous throughout.....11. *F. albomarginata*
- DD. Plants glandular-puberulent throughout.....
-11a. *F. albomarginata* var. *induta*
- CC. Pedicels 2–4 cm. long; fovea usually deeply 2-parted, with a conspicuous apical tooth.....12. *F. paniculata*

1. *F. speciosa* Dougl. in Hook. Fl. Bor. Am. 2: 66. 1840; Wats. Bot. Wheeler Exp. 279. 1871; Gray, Syn. Fl. N. Am. 2¹: 125. 1878; Coulter, Man. Bot. Rocky Mt. 246. 1885; Nels.

in Coult. & Nels. Man. Bot. Cent. Rocky Mts. 384. 1909; Wooton & Standl. in Contr. U. S. Nat. Herb. 19: 500. 1915; Tidestrom in Contr. U. S. Nat. Herb. 25: 417. 1925; Garrett, Spring Fl. Wasatch Reg. 119. 1927. Pl. 14, fig. 4.

Tessaranthium radiatum Kellogg in Proc. Calif. Acad. Sci. 2: 142. 1862.

Sweetia radiata (Kellogg) O. Ktze. Rev. Gen. 2: 430. 1891.

Frasera speciosa Dougl. var. *scabra* Jones, Zoe 4: 277. 1893; Nels. in Coult. & Nels. Man. Bot. Cent. Rocky Mts. 384. 1909.

F. venosa Greene, Pittonia 4: 185. 1900; Wooton & Standl. in Contr. U. S. Nat. Herb. 19: 500. 1915.

F. macrophylla Greene in Pittonia 4: 186. 1900.

F. ampla Greene, *ibid.*

F. speciosa Dougl. var. *stenosepala* Rydb. in Bull. Torr. Bot. Club 31: 632. 1905.

F. speciosa Dougl. var. *angustifolia* Rydb. *ibid.*

F. stenosepala Rydb. *ibid.* 33: 149. 1906; Wooton & Standl. in Contr. U. S. Nat. Herb. 19: 500. 1915.

F. angustifolia Rydb. in Bull. Torr. Bot. Club 33: 149. 1906.

Tessaranthium macrophyllum (Greene) Rydb. Fl. Rocky Mts. 666. 1917, and ed. 2, 666. 1922.

T. speciosum (Dougl.) Rydb. *ibid.*

T. scabrum (Jones) Rydb. *ibid.*

T. stenosepalum Rydb. *ibid.*

T. angustifolium Rydb. *ibid.*

Biennials or short-lived perennials from a thickened, somewhat woody tap-root; stem 0.3–2 m. high, erect, unbranched, foliose, terete, glabrous to scabrous; leaves in whorls of 3–4, membranous, entire, strongly parallel-veined, usually somewhat scabrous or puberulent, occasionally glabrous or glabrate; the basal leaves oblong to oblanceolate, spatulate, 25–50 cm. long, 3–9 cm. broad, gradually narrowed into an obscure, winged petiole; the cauline leaves sessile, linear to oblong-lanceolate, 5–15 cm. long, 1–2.5 cm. broad; inflorescence a terminal, cymose, fasciculate panicle; the pedicels clustered, 1–8 cm. long; the bracts opposite or 3–4-whorled, linear to lanceolate, 2–10 cm. long; calyx-lobes nearly distinct, linear to lanceolate, subulate, 1.5–2.5 cm. long; corolla-lobes deeply cleft, ovate to oblong-ovate, 1.5–2.5 cm. long, 0.5–

0.8 cm. broad, usually somewhat tapered at the apex, white or somewhat greenish, frequently maculate, bearing a pair of fimbriate, oblong foveae upon the ventral surface; fringe of the crown 3–5 mm. long, almost equalling the length of the foveae; capsule 2–2.5 cm. long, 1–1.5 cm. broad, partially enclosed within the persistent perianth, compressed contrary to the valves.

Distribution: from the Black Hills of South Dakota, south to New Mexico, west to California, Oregon, and Washington. A montane species occurring chiefly at altitudes from 5000–9000 feet.

Specimens examined:

SOUTH DAKOTA: Piedmont, 1893, *Pratt* (C); Black Hills National Forest, 15 June 1910, *Murdoch 4098* (F).

MONTANA: July 1894, *Mrs. Moore* (M); Belt Mountains, 12 July 1860, *Hayden* (M); Henry's Lake and Mt. Chauvet, 29 July 1897, *Rydberg & Bessey 4698* (F); Helena, June 1891, *Kelsey* (F); Helena, July 1892, *Starz* (F); head of Prickly Pear Creek, July 1883, *Scribner 156* (F, G).

WYOMING: Laramie Peak, Albany Co., open foothills, 10 July 1900, *A. Nelson 7516* (M, G); Medicine Bow Mt., Aug. 1856, *H. Engelmann* (M); Mammoth Hot Springs, moist open slopes, 1 July 1899, *Nelson & Nelson 5629* (M, G); Jackson's Hole, 21 Aug. 1894, *A. Nelson 935* (M, G); French Creek, near Laramie, 28 June–1 Aug. 1899, *Pammel 42* (M); head of Powder River and along Big Horn Mountains, Sept. 1859, *Hayden* (M).

COLORADO: Estes Park, Larimer Co., 16 June 1916, *E. L. Johnston 770B* (M); rocky banks near Tolland, Gilpin Co., 25 June 1926, *E. J. Palmer 31322* (M); Rollinsville, dry open plains, alt. 8500 ft., 9 July 1913, *Overholts* (M); Tongue Creek, Mesa, Delta Co., alt. 8000–9000 ft., Aug. 1892, *Purpus 304* (M); The Crags, 14 July 1901, *Clements & Clements 192* (M, G); mountains, Larimer Co., 1 July 1896, *Crandall* (M); Camerons Cove, Aug. 1900, *Harper & Harper 4959* (F); mountain-sides near Empire, 3 Aug.–8 Sept. 1892, *Patterson 243* (G, F, M); South Park, June 1873, *Wolf* (F); Keblar Pass, 14 Aug. 1901, *C. F. Baker 947* (M); Bob Creek, W. La Plata Mts., alt. 10,000 ft., 30 June 1898, *Baker, Earle & Tracy 271* (M, F, G); from the head-waters of Clear Creek and the alpine ridge lying east of "Middle Park," 1861, *Parry 310* (M, G); Ute Pass, 30 June 1886, *Trelease* (M);

arid slopes of Douglas Mt., Empire, 12 Aug. 1874, *G. Engelmann* (M); flank of Snowy Range, wet mountain valleys, alt. 9000 ft., 24 July 1872, *Redfield* (M); rocky summits above Idaho, alt. 8000–8500 ft., 31 July 1874, *G. Engelmann* (M); Stove Prairie Hill, 1 July 1896, *Crandall 1490* (F); Pike's Peak, 1890, *Carleton* (C); region of Pike's Peak, alt. 6000–13000 ft., July–Aug. 1912, *Brumbach & Davies 115* (F); near Manitou, alt. 7200 ft., 11 July 1884, *Letterman 309* (M, F); river bottom, Bayfield, 9 Aug. 1917, *Payson & Bethel 1153* (M); Middle Mountains, 1862, *Hall & Harbour 553* (F); Pagosa Springs, 25 July 1899, *C. F. Baker 524* (G); near Pagosa Peak, alt. 10000 ft., Aug. 1899, *C. F. Baker 525* (M); Keblar Pass, alt. 10000 ft., 14 Aug. 1901, *C. F. Baker* (G).

NEW MEXICO: Winsor Creek, in the Pecos River National Forest, alt. 8600 ft., 29 June 1908, *Standley 4034* (F, G); in and around the south end of the Black Range, Kingston, Sierra Co., alt. 6600 ft., 13 July 1904, *Metcalf 1160* (M, G); vicinity of Las Vegas, San Miguel Co., Aug. 1923, *Anect 134* (M); Hermits Peak, Aug. 1884, *Snow* (M); Sandia Mts., 23 July 1903, *Hedgcock* (M); in forest of Douglas spruce and rock pine, Haynes Canyon, Alamo National Forest, 10 Aug. 1911, *Barlow* (F); in Grant Co., in the vicinity of Silver City, Fort Bayard, Santa Rita, Fierro, and on the GOS Ranch near Hodge's house, 27 Aug.–12 Sept. 1911, *Holzinger* (M); Balsam Park, Sandia Mts., alt. 8200 ft., 4 July 1914, *Ellis 152* (M); in the Mogollon Mts., on or near the west fork of the Gila River, Socorro Co., alt. 7500 ft., 7 Aug. 1903, *Metcalf 411* (M, G); valley of Santa Fe Creek, June 1847, *Fendler 686* (M).

IDAHO: wooded slope, Salmon, Lemhi Co., alt. 5500 ft., 4 July 1920, *Payson & Payson 1893* (M); 4 miles south of Ketchum, 23 July 1895, *Henderson 3558* (M).

UTAH: alpine rocky crests, Dyer Mine, Uintah Mts., 5 July 1902, *Goodding 1255* (M, G); in the vicinity of Clayton Peak, Wasatch Mts., alt. 9000 ft., 12–26 Aug. 1903, *Stokes* (M); gravel, Fish Lake, alt. 10000 ft., 2 Aug. 1894, *M. E. Jones 5710* (M); Salt Lake City and vicinity, 7 July 1908, *Clemens* (M, G); American Fork Canyon, alt. 7500 ft., 27 July 1880, *M. E. Jones 1878* (M).

ARIZONA: Pine, *M. E. Jones* (M); Rincon Mts., 1891, *Neally 81* (M); Willow Spring, July 1874, *Rothrock 251* (M, F); without locality, 1877, *E. Palmer 304* (M); near soldier's camp, Santa Catalina Mts., 13 July 1916, *Harris C. 16296* (M); moist soil, Huachuca Mts., alt. 8000 ft., 8 July 1884, *Pringle* (M, G); in the vicinity of Flagstaff, alt. 7000 ft., 5 July 1898, *MacDougal 236* (M, G); Chiricahua Mts., alt. 8500 ft., 13 Aug. 1907, *Blumer 1619* (M).

WASHINGTON: Yakima region, 1882, *T. S. Brandegee 14840* (M).

OREGON: moist borders of pine woods, Bates Lumber Co., near Austin, E. Grant Co., 5 June 1925, *Henderson 5324* (M, G); Steins Mts., opposite Devine Ranch, along streams, alt. 1890 m., 7 July 1896, *Leiberg 2426* (M, G).

CALIFORNIA: Faith Valley, Alpine Co., alt. 8000 ft., Aug. 1892, *Hansen 595* (M); south fork of San Joaquin River, alt., 9000 ft., July 1900, *Hall & Chandler 716* (M); near Yosemite, Sierra Nevada, 1875, *Muir 5024* (M); about Summit Lake, near the summit of Mt. Sanhedrin, 15 July 1902, *A. A. Heller 5883* (M, G); without locality, 186-, *Bolander 6361* (G).

2. *F. caroliniensis* Walt. Fl. Carol. 87. 1788; Torr. Fl. N. & M. US. 187. 1824; Torr. Fl. N. Y. 2: 109. 1843; Gray, Man. Bot., ed. 7, 659. 1908. Pl. 14, fig. 6.

Swertia difformis L. Sp. Pl. ed. 1, 1: 226. 1753, and ed. 2, 1: 328. 1762.

Frasera Walteri Michx. Fl. Bor.-Am. 1: 97. 1803; Barton, Veg. Mat. Med. U. S. 2: 103. 1818; Ell. Sketch Bot. S. Car. & Ga. 205. 1824; Darby, Bot. S. States, 437. 1855.

F. officinalis Barton, Fl. Virg. 49. 1812.

Swertia Frasera Sm. in Rees, Cycl. 34: 1819.

Frasera verticillata Raf. Med. Fl. 1: 196. 1828.

"*Frasera carolinensis* Walt." acc. to Hook. Fl. Bor.-Am. 2: 66. 1840; Chapman, Fl. S. U. S. ed. 2, 357. 1889; Small, Fl. S. E. U. S. 931. 1903, and ed. 2, 931. 1913; Britt. & Brown, Ill. Fl. 3: 15. 1913.

Sweertia carolinensis O. Ktze. Rev. Gen. 2: 430. 1891.

Perennials from a much-thickened, somewhat woody tap-root; stem 1-1.5 m. high, erect, unbranched, foliose, terete, glabrous; leaves in whorls of 3-5 (usually 4), membranous, entire, penni-

nerved, glabrous; the basal leaves obovate to oblanceolate, 20–35 cm. long, 4–8 cm. broad, gradually narrowing into an obscure petiole; the cauline leaves sessile, oblong-lanceolate, 5–20 cm. long, 1–5 cm. broad; inflorescence a terminal, compound, open paniculate cyme; the peduncles clustered, 4–12 cm. long; the foliaceous bracts opposite or 3–4-whorled, lanceolate, 2–10 cm. long; calyx-lobes nearly distinct, lanceolate, mucronate, somewhat subulate, 20 mm. long, 2 mm. broad; the corolla-tube shallow, lacking a conspicuous crown; the lobes deeply cleft, ovate, 10–20 mm. long, 4 mm. broad, tapered at the apex, light greenish-yellow, marked with small brown-purple dots, bearing on the ventral surface a single, circular, fimbriate fovea; capsule 2 cm. long, 1 cm. broad, flattened parallel to the valves, partially enclosed within the persistent perianth; seeds dark brown, oblong, 0.9–1 cm. long, 0.4–0.5 cm. broad, pitted, conspicuously winged.

Distribution: from the Carolinas north to Michigan and west to Missouri. A species usually occurring in rich soil of open woodlands.

Specimens examined:

NORTH CAROLINA: mountains of North Carolina, 1878 (F).

GEORGIA: Estatoah Falls on Mud Creek, Rabun Co., alt. 3000 ft., 12 Aug. 1893, *Small* (M, F).

ALABAMA: Lookout Mt., Collinsville, De Kalb Co., 29 June 1897, *Eggert* (M).

MISSISSIPPI: Agric. College, Oktibbeha Co., 10 May 1892, *Tracy 1348* (M).

MICHIGAN: dry open woods, Kalamazoo Co., 27 July 1874, *Tuthill 9* (F); roadsides, Jackson Co., 22 June 1897, *Camp & Camp* (M, F); Jackson Co., 11 June 1897, *Camp & Camp* (M).

INDIANA: Hanover, May 1882, *Young* (M).

KENTUCKY: margins of woods, along small streams, near Dawson Springs, Caldwell Co., 29 May 1920, *E. J. Palmer 17689* (M); rocky fields, roadsides, Bowling Green, 1 June 1893, *Price* (M).

TENNESSEE: open woods, Lookout Mt., near Chattanooga, 17 May 1911, *Churchill 659* (M); wooded slope, Lookout Mt., near Chattanooga, 20 May 1911, *Churchill* (M).

ILLINOIS: Carbondale, 1871, *French* (M); rocky hills, Belknap, Pulaski Co., 13 May 1919, *E. J. Palmer 15132* (M); open woods about Belleville, May 1846, *Hilgard* (M); open woods east of Belleville, June 1834, *G. Engelmann 441* (M); Carbondale, 31 May 1885, *Wislizenus 343* (M).

MISSOURI: Big River, near Irondale, 24 May 1924, *Drushel* (M); Iron Mountain Lake, Iron Co., 28 May 1921, *Drushel* (M); rocky hills near Big River, St. Francois Co., 3 July 1892, *Eggert* (M); woods near Mine La Motte, Madison Co., 23 June 1898, *Eggert* (M); Bonne Terre, 31 Aug. 1891, *Eggert* (M); dry prairies, near Woodlawn, Jefferson Co., 16 May 1898, *Eggert* (M); De Soto, Jefferson Co., 25 May 1896, *Eggert* (M); rocky hillsides, Jefferson Co., 25 May 1896, *Eggert* (M); rocky hills, near Big River, St. Francois Co., 31 Aug. 1891, *Eggert* (M); "Stony hills," St. Francois Co., 31 Aug. 1891, *Eggert* (M); sandy ground, Scott Co., 20 May 1894, *Eggert* (M); rocky hillsides, near Big River, 31 Aug. 1891, *Eggert* (M); Mine La Motte, Madison Co., 19 May 1927, *Greenman, Larsen & Beardsley* (M); Iron Mountain Lake, 31 May 1925, *Kellogg 1931* (M); open woods along small streams, near Bismarck, St. Francois Co., 25 June 1920, *E. J. Palmer 18075* (M); 10 July 1887, *Hasse* (F); roadside, Des Arc, Iron Co., 6 May 1908, *H. H. Smith 405* (F); rocky, wooded hillsides near Shirley, Washington Co., 29 May 1924, *E. J. Palmer 25210* (M); Big River, Desloge and Bonne Terre, 28 Aug. 1898, *Trelease 1130* (M).

3. *F. fastigiata* (Pursh) Heller in Bull. Torr. Bot. Club **24**: 312. 1897; Piper in Contr. U. S. Nat. Herb. **11**: 451. 1906; Piper & Beattie, Fl. S. E. Wash. 193. 1914. Pl. 14, fig. 11.

Swertia fastigiata Pursh, Fl. Am. Sept. 101. 1814.

Frasera thyrsiflora Hook. Lond. Jour. Bot. **3**: 288. 1851; Gray, Syn. Fl. N. Am. **2**¹: 125. 1878; Howell, Fl. N. W. Am. 448. 1897.

"*Sweertia fastigiata* Pursch" acc. to O. Ktze. Rev. Gen. **2**: 430. 1891.

Biennial or short-lived perennial from a thickened tap-root; stem 6–10 dm. high, erect, unbranched, foliose, terete, glabrous; leaves usually in whorls of 3, entire, membranous, penninerved,

glabrous; the basal leaves broadly obovate to oblanceolate, 15–30 cm. long, 5–10 cm. broad, narrowing into an obscure petiole; the cauline leaves sessile, obovate, 4–12 cm. long, 1.5–6 cm. broad; inflorescence a terminal, interrupted, fasciculate, cymose panicle; the peduncles clustered, 2–6 cm. long; the bracts opposite, or 3–4-whorled, lanceolate, 2–10 cm. long; calyx-lobes almost distinct, somewhat subulate, 2 cm. long, 0.2 cm. broad; corolla-tube shallow, lacking a conspicuous crown; the lobes deeply cleft, oblong-lanceolate, 0.8–1. cm. long, 0.3 cm. broad, acute, pale blue, bearing on their ventral surfaces single, circular, fimbriate foveae; capsule 1.5 cm. long, 0.5 cm. broad, flattened parallel to the valves, partially enclosed within the persistent perianth; seeds oblong to oval or roughly triangular, 0.5–0.6 cm. long, 0.3 cm. broad, pitted or rugose, usually winged.

Distribution: northern Idaho and adjacent Washington.

Specimens examined:

IDAHO: on gravelly open hillsides, Moscow Hills, Latah Co., 25 June 1896, *Elmer 340* (M); Cedar Mts., Latah Co., June 1899, *Elmer 1688* (M); pine groves of foothills, Kamiac Buttes, June 1897, *Elmer 802* (M); Thatuna Hills, 5 July 1926, *Epling & Houck 9147* (M); about Lake Waha, Nez Perces Co., alt. 2000–3500 ft., 24 June 1896, *Heller & Heller 3285* (M); near Moscow and St. Maries R., 26 May–8 Aug. 1894, *Henderson 2271* (G); in low, rich woods, Kootenai Co., June 1891, *Leiberg 213* (M); Santianne Creek bottom, alt. 980 m., 25 June 1895, *Leiberg 1064* (M, G); Cedar Mts., Latah Co., 16 July–7 Aug. 1893, *Piper 1618* (M, F, G); meadows, Kootenai Co., June 1892, *Sandberg* (M); rich moist woods, Kootenai Co., June 1880, *Sandberg* (M, F); vicinity of Lake Waha, Nez Perces Co., 23 May 1892, *Sandberg, MacDougal & Heller 239* (F, G); base of mountains, near the Clearwater, 26 Aug. 1880, *Watson 270* (G).

WASHINGTON: Spokane Co., 1892, *Henderson 2271* (G); Clearwater, *Spalding* (G); damp grounds in open woods, Spokane Co., 5 June 1889, *Suksdorf 938* (F, M); damp grounds in open woods, Spokane Co., 5 June 1889, *Suksdorf 939* (G).

4. *F. neglecta* Hall in Bot. Gaz. 31:388. 1901. Pl. 14, figs. 8, 12.
Swertia neglecta (Hall) Jepson, Man. Fl. Pl. Calif. 766. 1925.

Perennial from a rhizome; stem 3.0–4.0 dm. high, erect, unbranched, subscapose, terete, glabrous; leaves opposite, subcoriaceous, glabrous; the basal leaves almost sessile, linear, 5–18 cm. long, 0.4–0.8 cm. broad, with white, somewhat serrate, crisped margins, becoming entire towards the apex; the cauline leaves sessile, linear, 3–8 cm. long, 0.4–0.6 cm. broad; inflorescence an elongated, interrupted, fasciculate cyme; the peduncles clustered, 1–12 cm. long; the bracts foliaceous, somewhat scarious, sessile, linear, 2–10 cm. long, distinct or united at the base; calyx-lobes nearly distinct, conspicuously subulate, 0.5 cm. long, 0.1 cm. broad, scarious-margined; the corolla-tube shallow, lacking a conspicuous crown; corolla-lobes deeply cleft, oblong, acuminate, 0.8–1 cm. long, 0.4 cm. broad, greenish-white, purple-veined, bearing on the ventral surface an oblong fovea, the lower part of the fovea often continuous with the tissue of the petal, sometimes 2-toothed or 2-lobed, the upper part saccate with the marginally fimbriate, circular orifice somewhat raised above the petal-surface; capsule flattened parallel to the valves, partially enclosed within the persistent perianth.

Distribution: California, chiefly along the northern slopes of the San Bernardino Mountains.

Specimens examined:

CALIFORNIA: Swartout Canyon, desert slopes of the San Gabriel Mountains, alt. 6500 ft., 5 July 1908, *Abrams & McGregor 628* (G); Acton, Mt. Gleason, Los Angeles Co., June 1902, *Elmer 3609* (G); north fork, Mt. Pinos, Ventura Co., alt. 1750 m., 28 June 1905, *H. M. Hall 6462* (C, F); Swartout Canyon, alt. 6860 ft., 3–6 June 1900, *H. M. Hall 1495* (M, F, G, C TYPE); Holcomb Valley, San Bernardino Mts., alt. 8000 ft., June 1886, *Parish & Parish* (C); dry ridges, Holcomb Valley, San Bernardino Mts., Aug. 1882, *Parish & Parish 1474* (G); Holcomb Valley, San Bernardino Mts., alt. 7300 ft., 16 June 1916, *S. B. Parish 10921* (C).

5. *F. montana* Mulford in Bot. Gaz. 19: 119. 1894.

Pl. 14, fig. 15.

Leucocraspedum montanum (Mulford) Rydb. Fl. Rocky Mts. 665. 1917, and ed. 2, 665. 1922.

Perennial from rhizomes; stem 3.0–4.5 dm. high, 0.3–1 cm. thick at the base, erect, unbranched, subscapose, terete, glabrous; leaves opposite, entire, membranous, parallel-veined, glabrous; basal leaves narrowly oblanceolate, 3–12 cm. long, 0.3–0.5 cm. broad; cauline leaves linear, 3–12 cm. long, 0.2–0.3 cm. broad; inflorescence a terminal fasciculate cyme, about 3 cm. broad; peduncles clustered, 1–3 cm. long; bracts opposite, foliaceous, 2–4 cm. long; calyx-lobes almost distinct, narrowly subulate, 0.5 cm. long, 0.1 cm. broad; corolla-tube shallow, corona small, deeply cut into two or more setae; the lobes deeply cleft, oblong, somewhat acute, 0.8 cm. long, 0.2–0.3 cm. broad, creamy white, bearing on the ventral surface a single obovate, fimbriate, basally saccate fovea; capsule flattened contrary to the valves, partially enclosed within the persistent perianth.

Distribution: known only from "mountain beyond Pioneer," Idaho.

Specimens examined:

IDAHO; Pioneer, alt. 5000 ft., 26 July 1892, *Mulford* (F TYPE); mountain beyond Pioneer, 23 July 1892, *Mulford* (M, G).

6. *F. nitida* Benth. Pl. Hartw. 322. 1839; Brew. & Wats. Bot. Calif. 484. 1876; Gray, Syn. Fl. N. Am. 2¹: 126. 1878; Howell, Fl. N. W. Am. 448. 1897; Piper in Contr. U. S. Nat. Herb. 11: 452. 1906. Pl. 14, figs. 13, 14.

Swertia nitida (Benth.) Jepson, Man. Fl. Pl. Calif. 766. 1925.

Frasera nitida Benth. var. *albida* Suksdorf, Werdenda 1: 30. 1927.

Perennial from a branching somewhat woody rhizome; stems 25–50 cm. high, 0.2–0.3 cm. in diameter at the base, erect, unbranched, subscapose, terete, glabrous; leaves opposite, entire, often conspicuously white-margined, parallel-veined, glabrous; the basal leaves spatulate to sublinear, 5–25 cm. long, 0.5–1 cm. broad; cauline leaves sessile, narrowly oblanceolate to sublinear, 5–10 cm. long, 0.3–0.5 cm. broad; inflorescence a terminal, interrupted, racemose cyme; peduncles clustered, 0.5–4 cm. long; bracts opposite, foliaceous, sublinear, 4–12 cm. long; calyx-lobes nearly distinct, somewhat subulate, tapering to a sharp point, 0.6–0.7 cm. long; corolla-tube shallow with a conspicuous petal-

loid corona; the lobes ovate to oblong, acute, 0.7–0.8 cm. long, 0.3 cm. broad, greenish, bearing on their ventral surfaces single, oblong, deeply fringed, saccate foveae; capsule 1.5 cm. long, 0.5 cm. broad, flattened parallel to the valves, partially enclosed within the persistent perianth; seeds few, often only four, oblong, 0.7 cm. long, 0.3 cm. broad, closely appressed, brown, thick-margined, wingless, pitted.

Distribution: western Idaho, west to southern Washington, south to southern California.

Specimens examined:

IDAHO: dry stony hills near Cuprum, 10 July 1899, *Cusick 2226* (C, F, G).

WASHINGTON: Klickitat, June 1879, *Howell* (M); Klickitat Co., 27 May–Aug. 1881, *Suksdorf 40* (G); hillsides, W. Klickitat Co., 27 May, *Suksdorf 161* (F); hillsides, W. Klickitat Co., 27 May 1881, *Suksdorf* (C).

OREGON: dry prairies, eastern Oregon, July 1880, *Howell* (F); open grassy hillsides, 13 May 1924, *Henderson 467* (M); Dalles, Wasco Co., 23 May 1910, *A. A. Heller 10087* (G); Siskiyou Mts. 19 Aug. 1880, *G. Engelmann* (M); Woodville, Jackson Co., 5 July 1893, *Hammond 277a* (M); near camp by Grizzly Butte, Crook Co., alt. 840 m., 14 June 1891, *Leiberg 227* (G, C); Oregon Boundary Commission, Columbia River, lat. 46–49° N., *Lyall 1860* (G); dry ground along Silvies River at mouth of Emigrant Creek, Harney Co., 25 June 1912, *Peck 4501* (F); Odessa, Short Creek Hill, Klamath Co., alt. 4200 ft., 30 June 1910, *Rose 1624* (M).

CALIFORNIA: Plumas Co., *Mrs. R. M. Austin* (F); gravelly red soil, alt. 4500 ft., 20 July 1893, *M. S. Baker* (C); Morley's Station, Shasta Co., 22 May 1894, *M. S. Baker & Nutting* (C); Cherokee, Butte Co., May 1879, *Bidwell* (G); Battle Rock Mt., Lake Co., 1 July, *K. Brandegee* (C); Prattsville, Plumas Co., 9 July 1892, *T. S. Brandegee* (C); south side of Mt. Shasta, Siskiyou Co., alt. 5000–10000 ft., 15–31 July 1897, *H. E. Brown 545* (F); dry land near Yreka, Siskiyou Co., 2 June 1910, *Butler* (C, M); Klamath River, Humboldt Co., alt. 1400 ft., June 1901, *Chandler 1486* (C, M); Hupa Indian Reservation, alt. 500 ft., June 1901, *Chandler 1383* (C); Castle Lake Trail, Shasta Region, Aug. 1910, *Congdon*

(C); lower slopes of Hoopa Mt., Humboldt Co., on the borders of Supply Creek, 21 June 1899, *Davy 5737* (C); Cantara, Siskiyou Co., 28 Aug. 1912, *Eastwood 1945* (G); Nevada City, Nevada Co., 20–22 June, 1912, *Eastwood 582* (C); Goose Valley, Shasta Co., 29 June–11 July 1912, *Eastwood 950* (G); Scotts Mt., alt. 5000–7000 ft., 30 Aug. 1880, *G. Engelmann* (M); near Yreka, Siskiyou Co., 14 June 1876, *Greene 856* (M); lava beds of north-eastern Shasta Co., alt. 4000 ft. alt., June 1903, *Hall & Babcock 4241* (C); Cobb Mt., 500 ft. below summit, 28 July 1913, *Hall 9594* (M, G, F, C); Bear River, Nevada County, alt. 1400 ft., 5 June 1916, *Hall 10157* (C); Coffee Creek Canyon, Salmon Mts., Trinity Co., alt. 1260 m., 16 July 1909, *Hall 8546* (G, M, F); Pitt River Canyon, alt. 1000 ft., June 1903, *Hall & Babcock 4006* (C); near Nash Mine, alt. 4100 ft., 16 July 1909, *Hall 8546* (C); near Redding, Shasta Co., 27 May 1905, *A. A. Heller* (C); grade between Greenville and Prattsville, Plumas Co., 12 July 1907, *Heller & Kennedy 8820* (G); near Redding, Shasta Co., 27 May 1905, *A. A. Heller 7879* (G); dry gravelly slope, north side of Mt. Eddy, Siskiyou Co., alt. 4500 ft., 16 July 1915, *A. A. Heller 12103* (F, M); Mt. Hanna, Lake Co., 15 July 1897, *Jepson* (G); near Prattsville, at Mt. Meadow, alt. 5500 ft., 2 July 1897, *M. E. Jones* (M); Redding, 16 May 1910, *W. W. Jones 222* (G); Sierra Co., 1874, *J. G. Lemmon* (C 174108); Holcomb Valley, San Bernardino Mts., alt. 8000 ft., Aug. 1882, *Parish & Parish 1474* (F); Redding, Shasta Co., 24 May 1913, *L. E. Smith 235* (G); Cobb Mt. on south side, alt. 2000 ft., 12 July 1905, *J. P. Tracy 2244* (C); Trinity Co., June 14, *Yates 19385* (C).

6a. Var. *albicaulis* (Dougl.) Card, n. comb. Plate 14, fig. 9.

Frasera albicaulis Dougl. ex Griseb. in Hook. Fl. Bor.-Am. 2: 67. 1840; Gray in Syn. Fl. N. Am. 2¹: 126. 1878; Howell, Fl. N. W. Am. 1: 449. 1897; Piper & Beattie, Fl. S. E. Wash. 193. 1914.

"*Frasera albicaulis* Griseb." Gen. et Sp. Gent. 330. 1839; in DC. Prodr. 9: 131. 1845.

Sweetia albicaulis Dougl. ex O. Ktze. Rev. Gen. 2: 430. 1891.

Leucocraspedum albicaule Dougl. acc. to Jepson, Man. Fl. Pl. Calif. 766. 1925.

Frasera albicaulis Dougl. f. *alba* St. John in Proc. Biol. Soc. Wash. 41: 196. 1928.

Plant more or less puberulent; corolla with a more linear fovea.

Distribution: northwestern Idaho, eastern Washington, and northern Oregon.

Specimens examined:

IDAHO: Palouse Country and about Lake Coeur d'Alene, June, July 1892, *Aiton* (M); in the vicinity of Moscow, Latah Co., 16–20 June 1892, *A. A. Heller* (F); Upper Ferry, Nez Perces Co., May 1896, *Heller & Heller* (F); about Lewiston, Nez Perces Co., alt. 900 ft., 20 May 1896, *Heller & Heller* (M); open hillsides, Salmon, Lemhi Co., alt. 5000 ft., 27 June 1920, *Payson & Payson 1796* (M); meadows, valley of Clearwater River, Nez Perces Co., 3 May 1892, *Sandberg, MacDougal & Heller 101* (M, F); moist places, Kootenai Co., June 1887, *Sandberg* (F).

WASHINGTON: on dry hillsides, Pullman, Whitman Co., May 1897, *Elmer 823* (M); grassy hillsides, head of Hotwai Creek, Whitman Co., 27 May 1928, *English 994* (M); Pullman, 20 June 1893, *Piper 1619* (M); Spokane Co., June 1884, *Suksdorf* (F); prairies, Spokane Co., June 1884, *Suksdorf* (F).

OREGON: slightly moist ground, 10 miles north of Bonanza, Klamath Co., 24 June 1927, *Peck 15174* (M); cattle camp at head of Horse Creek, Wallowa Co., alt. 5400 ft., 24 June 1897, *Sheldon 8344* (M); dry ground near the Dalles, 2 July 1927, *Thompson 2851* (M).

6b. Var. *Cusickii* (Gray) Card, n. comb.

Plate 14, fig. 10; pl. 15, fig. 1.

Frasera Cusickii Gray in Proc. Am. Acad. **22**: 310. 1887; Howell, Fl. N. W. Am. 448. 1897.

Stems generally shorter than in the species, 15–20 cm. high; flowers larger, corolla-lobes 0.8–1 cm. long, 0.4 cm. broad.

Distribution: Idaho and Oregon.

Specimens examined:

IDAHO: open hillsides, Salmon, Lemhi County, alt. 5000 ft., 27 June 1920, *Payson & Payson 1796* (M).

OREGON: hillsides of Grande Ronde Valley, 1886, *Cusick 1427* (G TYPE); stony hillsides near Union, May 1886, *Cusick 1427* (C); sterile, stony ridges, southern Blue Mts., alt. 4000–5000 ft., June 1897, *Cusick 1635* (C, F, M); mountain sides of Grande Ronde Valley, near Union, 6 June 1898, *Cusick 1920* (F, G, M, C).

7. *F. coerulea* Mulford in Bot. Gaz. 19: 118. 1894.

Leucocraspedum coeruleum (Mulford) Rydb. Fl. Rocky Mts. 666. 1917, and ed. 2, 666. 1922.

Perennial from a branching rhizome; stem 1.5–2.5 dm. tall, erect, unbranched, foliose, terete, glabrous; leaves opposite, entire, membranous, white-margined, parallel-veined, glabrous; basal leaves narrowly oblanceolate, 5–20 cm. long, 0.5–1 cm. broad, petiole inconspicuous; cauline leaves sessile, linear, 4–8 cm. long, 5–6 cm. broad; inflorescence closely paniculate; pedicels 0.5–3 cm. long, 2–4 in the axils; calyx-lobes nearly distinct, slightly subulate, 0.5–0.7 cm. long, 1 mm. broad, scarious-margined; corolla-tube deeply cleft, corona conspicuous, petaloid, nearly as long as the fovea; corolla-lobes ovate, acute, 6–8 mm. long, bearing upon the ventral surface a fimbriate, linear fovea; capsule and seed not seen.

Distribution: Owyhee Mts., in southeastern Idaho, and Oregon.

Specimens examined:

IDAHO: Owyhee Mts., near Wagonville, alt. 7000 ft., 8 July 1892, *Mulford* (M, G, COTYPES); dry open slopes, De Lamar, Owyhee Co., alt. 7000 ft., 22 June 1911, *Macbride 961* (M, G, F).

OREGON: near camp by Grizzly Butte, Crook Co., alt. 840 m., 14 June 1894, *Leiberg 227* (M): head of Otis Creek, Blue Mts., 11 June 1897, *Cusick 1635* (G).

8. *F. tubulosa* Coville in Proc. Biol. Soc. Wash. 7: 71. 1891.

Pl. 14, fig. 5.

Swertia tubulosa (Coville) Jepson, Man. Fl. Pl. Calif. 767. 1925.

Biennial or short-lived perennial from a tap-root; stem about 6 dm. high, .6–1.0 cm. thick at the base, erect, unbranched, subscapose, terete, glabrous, glaucous; leaves in whorls of 5 or 6, entire, membranous, narrowly white-margined; basal leaves spatulate to oblanceolate, 4–9 cm. long, 1 cm. broad, obtuse, mucronate; inflorescence a terminal, narrow, spicate panicle 2–5 dm. long, interrupted below; the pedicels erect, 1–5 cm. long; bracts opposite, linear, 7–10 cm. long; calyx-lobes nearly distinct, linear, subulate, 0.6–0.8 cm. long; corolla-tube shallow; the lobes oblong-obovate, 0.8–1 cm. long, 0.2 cm. broad, acuminate, white,

bearing tubular foveae half as long as the corolla and saccate at the base, longitudinally 2-cleft at the apex; capsule oblong-lanceolate, 1 cm. long, .5 cm. broad, compressed parallel to the valves; seeds 6-10, oblong, flat and thin.

Distribution: Tulare and Inyo Counties, California.

Specimens examined:

CALIFORNIA: summit, west Olancha, Inyo Co., 21 June 1899, *S. W. Austin 117* (C); Kern River, Tulare Co., 3 Aug. 1904, *Culbertson 4329* (M, F, G); Kern River, Tulare Co., 3 Aug. 1904, *Eastwood 4329* (C); near Lion Meadow, basin of upper Kern River, Tulare Co., July 1904, *Hall & Babcock 5401* (C); Soda Springs, basin of upper Kern River, alt. 6300 ft., Tulare Co., July 1904, *Hall & Babcock 5412* (C); southwest side of Olancha Mountain, alt. 8500 ft., Tulare Co., 25-30 June 1904, *Hall & Babcock 5271* (C); plains along the Kern River, alt. 6000-7000 ft., Aug. 1895, *Purpus 1407* (C).

9. *F. puberulenta* Davidson in Bull. So. Calif. Acad. Sci. 11: 77. 1912. Pl. 14, fig. 7; pl. 15, fig. 2.

Perennial from a somewhat thickened tap-root; stem about 2.5 dm. high, erect, unbranched, foliose, closely puberulent throughout; leaves opposite, entire, white-margined, coriaceous, parallel-veined, puberulent; the basal leaves obovate, 5-10 cm. long, 1-5 cm. broad, gradually narrowing into a relatively long winged petiole; cauline leaves narrowly elliptical, 3-5 cm. long, 1.5 cm. broad; inflorescence a terminal somewhat open thyriform cyme; the peduncles clustered, 3-5 cm. long; the bracts opposite, foliaceous, 1-5 cm. long; calyx-lobes nearly distinct, narrowly lanceolate, slightly subulate, 1-1.5 cm. long, 2 mm. broad; corolla-tube shallow, crown lacking; the lobes oblong, 7 mm. long, 3 mm. broad, mucronate-setose, greenish white, conspicuously purple-dotted, bearing on the ventral surface a single oblong fimbriate fovea, saccate-sagittate at the base; capsules not seen.

Distribution: Inyo County, California.

Specimens examined:

CALIFORNIA: South Lake, Bishop Creek, Inyo Co., July 1911, *Davidson 2705* (C, LA TYPE).

10. *F. Parryi* Torr. Bot. Mex. Bound. Surv. 156. 1859; Gray, Syn. Fl. N. Am. 2¹: 126. 1878. Pl. 14, fig. 1.

Sweetia Parryi (Torr.) O. Ktze. Rev. Gen. 2: 430. 1891.

"*Swertia Parryi* (Torr.) Ktze," acc. to Jepson, Man. Fl. Pl. Calif. 767. 1925.

Perennial from a somewhat branched rhizome; stem 7–9 dm. high, erect, unbranched, scapose, terete, glabrous; leaves opposite, entire, more or less conspicuously white-margined, coriaceous, parallel-veined, glabrous; basal leaves subsessile, lanceolate, 10–15 cm. long, 1–2 cm. broad; cauline leaves sessile, lanceolate, 4–8 cm. long, 1–1.5 cm. broad; inflorescence a terminal, open, paniculate cyme; peduncles single in the axils, 4–6 cm. long; bracts opposite, foliaceous, broadly lanceolate, acute, 1–5 cm. long; calyx-lobes nearly distinct, broadly lanceolate, subulate, acute, 1–1.8 cm. long, 0.3–0.6 cm. broad; corolla-tube shallow, the corona reduced to cilia; the lobes ovate, narrowed at the base, 1.5 cm. long, 4–8 mm. broad, greenish-white, purple-dotted, bearing on the ventral surface near the base a single acute, lunate fovea; capsule 1.5–2 cm. long, 5–8 mm. broad, flattened contrary to the valves, partially enclosed within the persistent perianth; seeds oblong, 0.4 cm. long, 0.2 cm. broad, slightly thickened, rugose.

Distribution: southern California.

Specimens examined:

CALIFORNIA: between Walker's Ranch and the Jacumba, 1 June 1903, *Abrams 3701* (M, F); Witch Creek, San Diego Co., May 1894, *Alderson* (C); San Pedro Martin, 28 May 1893, *T. S. Brandegee* (C); Laguna Mts., San Diego Co., 20 June 1904, *T. S. Brandegee* (C); Ramona, Oct. 1903, *K. Brandegee* (C); east side of Palomar Mt., alt. 3500 ft., 11 July 1904, *Chandler 5468* (C); Badena, 15 Aug. 1884, *Coulter* (F); in the southeastern part of the Colorado Desert, San Diego Co., July 1890, *Gray* (M); San Diego, 1891, *Gregory* (C); in open pine forests in the vicinity of Strawberry Valley, alt. 5200 ft., July 1901, *Hall 2518* (C, M); Rincon Grade, 29 May 1926, *M. E. Jones* (C); summit of mountain near Crafton, San Bernardino Co., April 1876, *J. G. Lemmon* (F, C); San Bernardino, *J. G. Lemmon* (C); Jacumba Hot Springs, near Monument, 20 May 1894, *Mearns 3242* (M); Cuiamaca

Mts., July 1875, *E. Palmer* 229 (M); *Parry & Lemmon* 232 (M, F); San Bernardino Co., June 1876, *Parry & Lemmon* (M); foothills, June 1887, *S. B. Parish* (F); dry mesas, alt. 350 m., San Bernardino Valley, 24 May 1909, *S. B. Parish* 7084 (C); lower foothills, 29 June 1888, *S. B. Parish* (C); lower hills, alt. 360–400 m., San Bernardino Valley, 24 May 1909, *S. B. Parish* 7084 (C); foothills, San Bernardino Mts., 7 June 1892, *S. B. Parish* 2415 (F); foothills, San Bernardino Mts., 25 April 1885, *S. B. Parish* 312 (C); vicinity of San Bernardino, alt. 100–2500 ft., 12 May 1897, *S. B. Parish* (M); foothills, 15 June 1888, *S. B. Parish* (M); San Jacinto Mt., July 1880, *Parish & Parish* 312 (F); open ground, Seven Oaks, San Bernardino Mts., June 1902, *White* 2 (C).

11. *F. albomarginata* Wats. Bot. King Exp. 280. 1871; Gray, Syn. Fl. N. Am. 2¹: 126. 1878; Tidestrom in Contr. U. S. Nat. Herb. 25: 417. 1925. Pl. 14, fig. 3.

Sweertia albomarginata (Wats.) O. Ktze. Rev. Gen. 2: 431. 1891.

Leucocraspedum albomarginatum (Wats.) Rydb. Fl. Rocky Mts. 665. 1917, and ed. 2, 665. 1922.

“*Swertia albomarginata* (Wats.) Ktze.” acc. to Jepson, Man. Fl. Pl. Calif. 766. 1925.

Biennials or short-lived perennials from a thickened, somewhat woody tap-root; stem 2–6 dm. high, erect, unbranched, scapose, terete, glabrous; leaves 3–4-whorled, coriaceous, generally undulate, conspicuously white-margined, parallel-veined, glabrous; basal leaves sessile, oblanceolate, 5–10 cm. long, 0.8–1 cm. broad; cauline leaves sessile, linear, 2–8 cm. long, 0.4–0.8 cm. broad; inflorescence a terminal, corymbose cyme; the peduncles 0.5–10 cm. long, mostly solitary; bracts 1–6 cm. long, usually opposite, sometimes whorled, much-reduced in upper part of inflorescence; calyx-lobes nearly distinct, acute, somewhat subulate, 0.3–0.4 cm. long, 0.2 cm. broad; corolla-tube shallow, crown lacking; the lobes ovate-acuminate, 0.8–1 cm. long, 0.4–0.5 cm. broad, greenish-yellow, bearing on the ventral surface a linear, sparsely fringed obcordate fovea; capsule flattened contrary to the valves, partly enclosed within the persistent perianth; seeds oblong, 0.3–0.4 cm. long, wingless, rugose.

Distribution: southern Colorado to southern California.

Specimens examined:

COLORADO: Mesa Verde, July 1875, *T. S. Brandege* 1249 (C); southwest Colorado, *T. S. Brandege* 1215, 1249 (M); Mesa Verde, July 1889, *Eastwood* (C); rocky cedar barrens at summit of Soda Canyon, Tip-off Trail, Southern Ute Reservation, Montezuma Co., 27 June 1929, *Woodson & Anderson* 29006 (M).

UTAH: without locality, 1874, *Parry* 203 (G).

NEVADA: Pioche, 31 Aug. 1912, *M. E. Jones* (C); vicinity of Pioche, Lincoln Co., 28 June 1909, *Minthorn* (C).

ARIZONA: Oak Creek, 22 June 1883, *Rusby* (F).

CALIFORNIA: Providence Mts., San Bernardino Co., 6 June 1902, *T. S. Brandege* (C); without locality, 1887, *E. Palmer* 305 (M).

11a. *Var. induta* (Tidestrom) Card, n. comb.

Frasera induta Tidestrom in Contr. U. S. Nat. Herb. 25: 417. 1925.

Finely glandular-puberulent throughout, in all other essential characters similar to the species.

Distribution: southern Nevada.

Specimens examined:

NEVADA: gravelly slopes, Cottonwood Creek Canyon, alt. 5000–6000 ft., Aug. 1896, *Purpus* 3065 (C); Charleston Mts., alt. 5000–6000 ft., May–Oct. 1898, *Purpus* 6083 (C); between Owens and Lee Canyon, alt. 7000 ft., 24 July 1913, *A. A. Heller* 10981 (M, C, G, F).

12. *F. paniculata* Torr. in Pacif. R. R. Rept. 4: 126. 1856; Gray, Syn. Fl. N. Am. ed. 2, 2¹: 126. 1886; Wooton & Standl. in Contr. U. S. Nat. Herb. 19: 500. 1915. Pl. 14, fig. 2.

Sweertia Bigelowii O. Ktze. Rev. Gen. 2: 431. 1891.

Frasera utahensis Jones, Zoe 2: 19. 1891; Tidestrom in Contr. U. S. Nat. Herb. 25: 417. 1925.

Herbaceous, caulescent biennial or short-lived perennial, from a thickened somewhat woody tap-root; stem 7–10 dm. high, erect, unbranched, scapose, terete, glabrous; leaves opposite, entire, coriaceous, parallel-veined, glabrous; basal leaves lanceo-

late-acuminate, 10–20 cm. long, 1.5–4 cm. broad, slightly contracted at the base; the lower cauline leaves opposite, 8–10 cm. long, 1–1.5 cm. broad, clasping at the base; the upper leaves reduced to mere bracts; inflorescence a terminal, open panicle; peduncles usually solitary in the axils; bracts opposite, 2–10 cm. long; calyx-lobes nearly distinct, broadly ovate, 0.4 cm. long, 0.2 cm. broad, either acute or acuminate, whitish-margined; corolla-tube shallow, lacking a conspicuous crown; the lobes oblong-obovate, 1 cm. long, 0.7 cm. broad, tapered at the base, yellowish-green, purple-dotted, bearing on the ventral surface 2 oblong, linear, fimbriate, urn-shaped foveae with a conspicuous apical tooth; capsule 1.5 cm. long, 0.5 cm. broad, flattened contrary to the valves, partially enclosed within the persistent perianth; seeds 10–20, generally oblong, 0.7 cm. long, 0.3 cm. broad, closely appressed, unequally thickened, brown, pitted, rugose or irregularly tuberculate, somewhat winged-margined.

Distribution: New Mexico, Arizona, and adjacent Utah.

Specimens examined:

NEW MEXICO: along road northwest of Lybrook's Trading Post (Haynes), Rio Arriba Co., 4 July 1929, *Mathias 616* (M).

UTAH: near Moab, 16 June 1913 (G); Courthouse Wash, *M. E. Jones* (C).

ARIZONA: sand bluffs, Inscription Rock, Zuni Country, 18 Nov. 1853, *Bigelow* (G TYPE); House Rock, 18 June 1890, *M. E. Jones* (C); in sand on high mesa only, Navajo Reservation, July 1916, *Vorhies 43* (M, C, G); *Voth 80* (F); Pahrnagath Mts., 1871, *Searls* (G).

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| Aiton, G. B. — (6a). | Baker, M. S. & F. Nutting — (6). |
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| Anect, Bro. <i>134</i> (1). | Bidwell, Mrs. J. — (6). |
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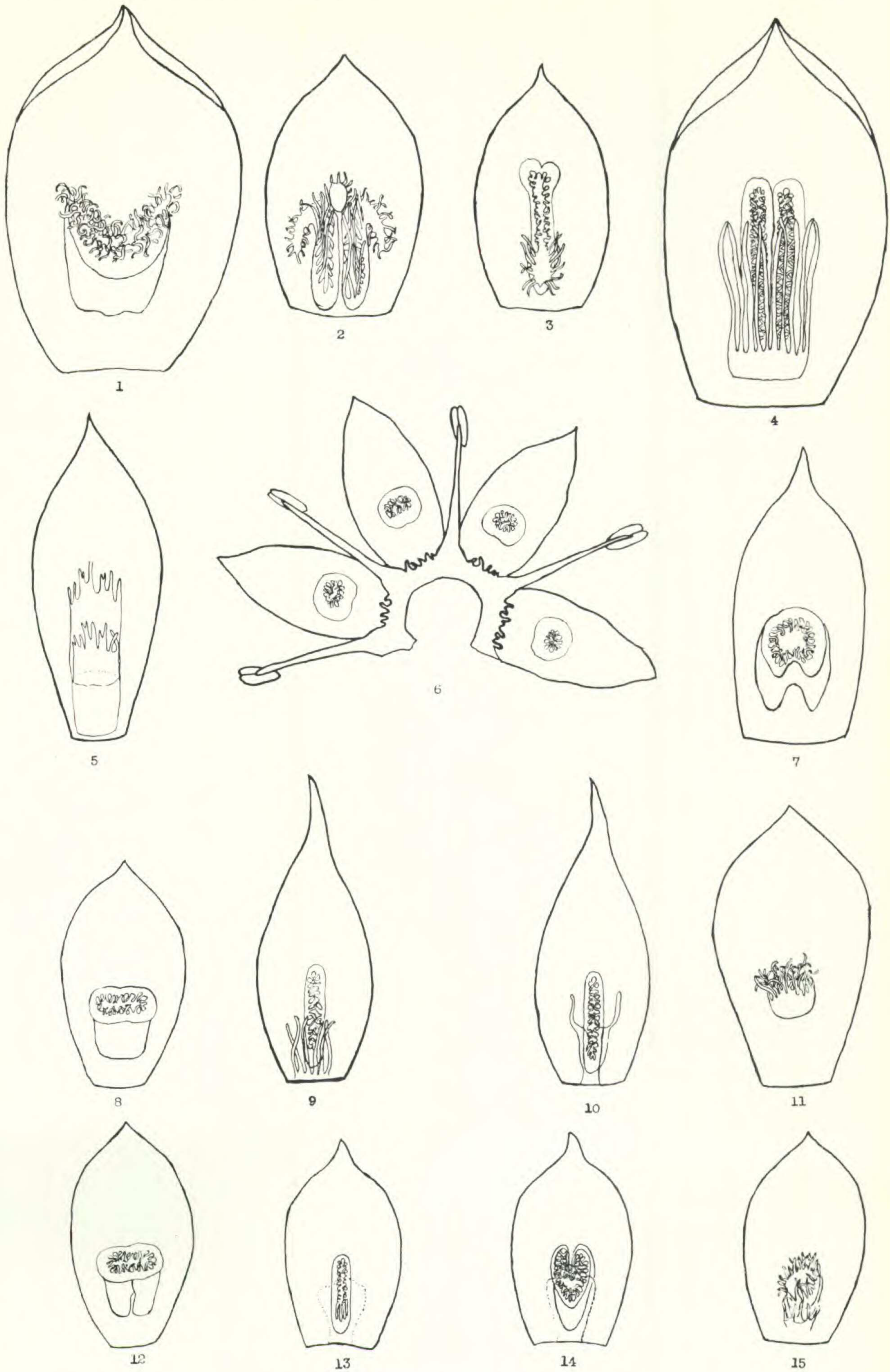
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EXPLANATION OF PLATE

PLATE 14

- Fig. 1. *F. Parryi*. Corolla-lobe and lunate fovea. $\times 6$.
Fig. 2. *F. paniculata*. Corolla-lobe and foveae. $\times 6$.
Fig. 3. *F. albomarginata*. Corolla-lobe and fovea. $\times 6$.
Fig. 4. *F. speciosa*. Corolla-lobe, foveae and crown. $\times 6$.
Fig. 5. *F. tubulosa*. Corolla-lobe and saccate fovea. $\times 6$.
Fig. 6. *F. caroliniensis*. Corolla, stamens and reduced crown. $\times 6$.
Fig. 7. *F. puberulenta*. Corolla-lobe and fovea. $\times 6$.
Fig. 8. *F. neglecta*. Corolla-lobe and fovea. $\times 6$.
Fig. 9. *F. nitida* var. *albicaulis*. Corolla-lobe, fovea and crown. $\times 6$.
Fig. 10. *F. nitida* var. *Cusickii*. Corolla-lobe, fovea and petaloid crown. $\times 6$.
Fig. 11. *F. fastigiata*. Corolla-lobe and fovea. $\times 6$.
Fig. 12. *F. neglecta*. Corolla-lobe with partly fused foveae. $\times 6$.
Fig. 13. *F. nitida*. Corolla-lobe, fovea, and crown. $\times 6$.
Fig. 14. *F. nitida*. Corolla-lobe, foveae almost fused. $\times 6$.
Fig. 15. *F. montana*. Corolla-lobe, fovea, and crown. $\times 6$.



CARD—REVISION OF FRASERA

EXPLANATION OF PLATE

PLATE 15

Fig. 1. Photograph of the type specimen of *Frasera nitida* Benth. var. *Cusickii* (Gray) Card, in the Gray Herbarium of Harvard University.

Fig. 2. Photograph of the type specimen of *Frasera puberulenta* Davidson, in the Herbarium of the Los Angeles Museum.